

Galvanic Corrosion Test Method for Coatings and Materials

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ASETS Defense 2012



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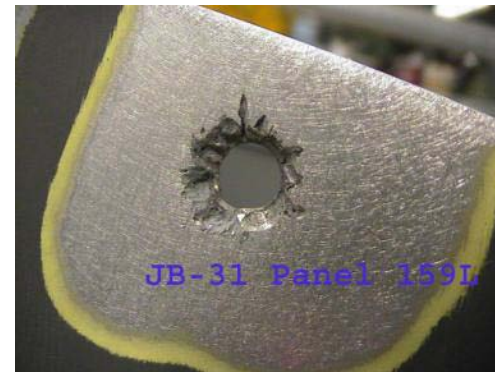
Galvanic Corrosion Basics

- Occurs when two or more dissimilar metals are brought into electrical contact in the presence of electrolyte
- Anode – sacrificial; corrodes faster than normal
- Cathode – corrodes slower than normal
- Electron Transfer from anode to cathode
- Corrosion rate can increase when:
 - Voltage difference increases
 - Cathodic surface area increases relative to anode



Why is the Navy concerned?

- Majority of all structural damage on US Navy and Marine Corps aircraft are at holes with galvanic incompatibility between aluminum and another material
- Commonly used test panels do not account for this failure mode and give no indication of primer effectiveness in slowing galvanic corrosion

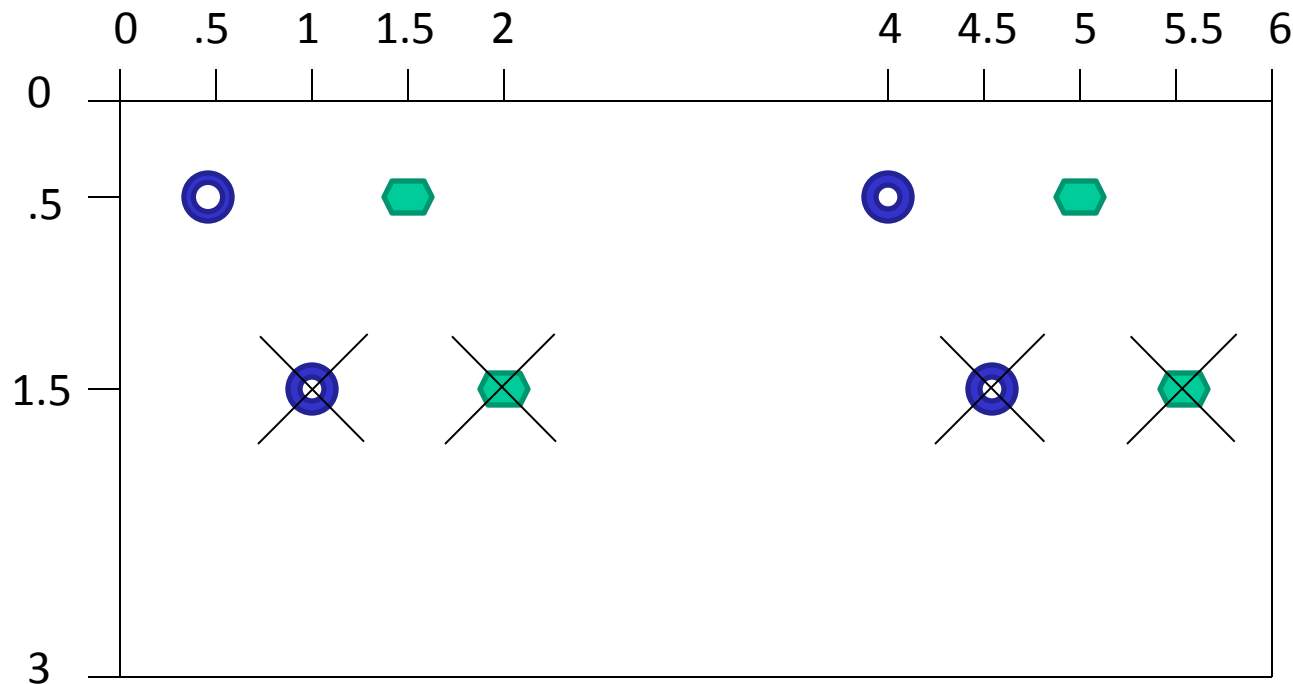


Galvanic Corrosion Drivers for Holes

- Dry installation
- Choice of strong cathode (CRES worse than Ti due to higher cathodic current density)
- Low performing protection schemes
- Cathodic coatings (conductive paint, sealants, LO materials)
- Damage to protective materials
- Improper or low quality repair




NAVAIR Galvanic Assemblies



Notes:

1. Fabricate coupons from AA2024-T3 and AA7075-T6
2. Coupon size: 3" X 6" X .25"
3. Drill #11 holes 8 places
4. Debur all holes and surfaces

5.  Titanium Hardware

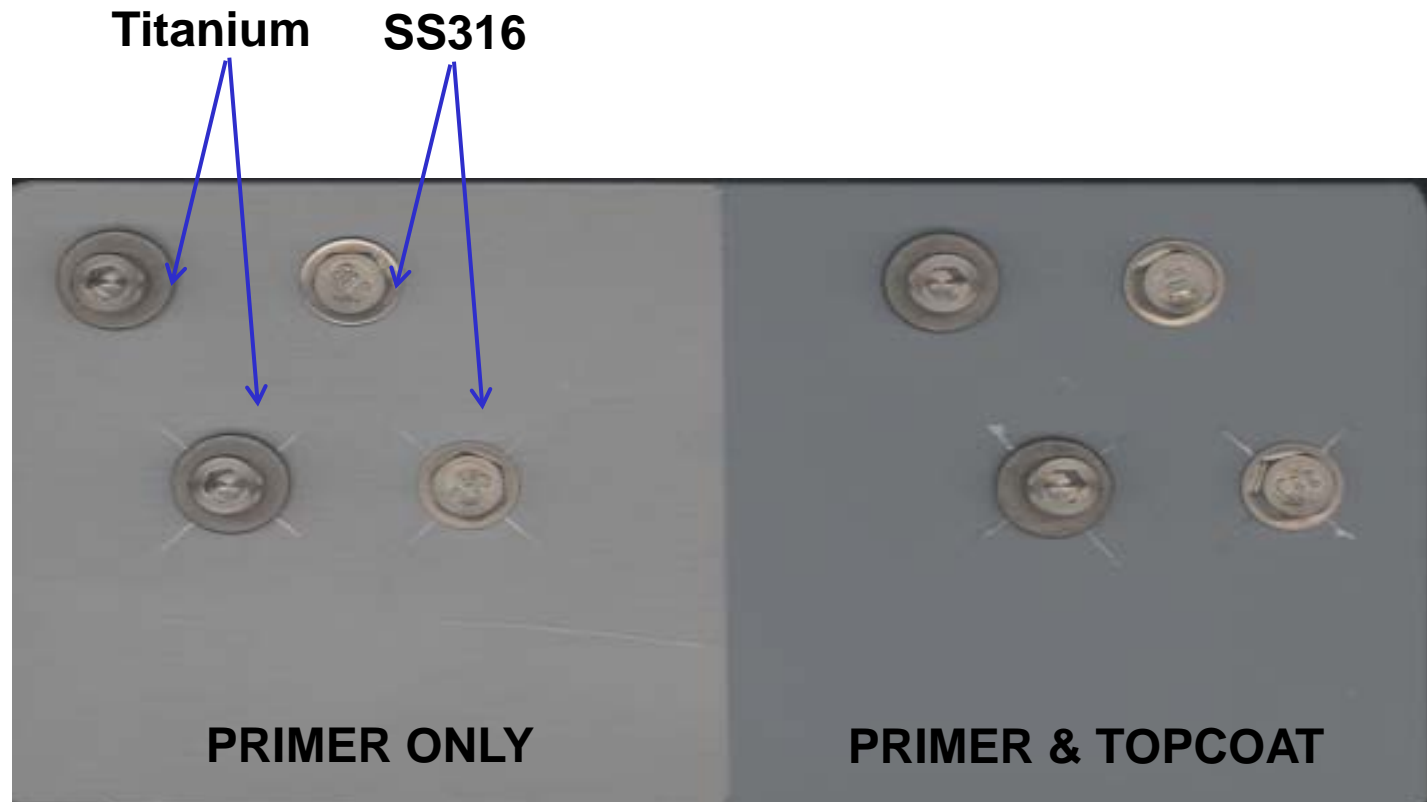
6.  Stainless Steel Hardware

7. Install Titanium Hardware 4 places., 10-32 x 0.75 Socket Cap Screw 6AL-4V, 6AL-4V 10-32 washers and 10-32 6AL-4V hex nut, A product of RIGHTech Fabrications Northbrook IL
8. Install Stainless Steel Hardware 4 places, 10-32 X 3/4" hex machine 316 SS bolts, 10-32 316 SS flat washers, 10-32 hex nut 316 SS, Product of Hardware Specialties Co., Inc, Long Island City NY
9. Torque All bolts to 100 in oz.
10. Scribe bottom row of bolts 4 places, make an "X" over the hole with each line extending 1/2" from the center of the hole.



NAVAIR Galvanic Assemblies

Representative of worst case observed installation of fasteners in aluminum structure



Rating Method

1 st Digit- Scribe appearance		2 nd Digit – Undercutting (ASTM 1654)			3 rd Digit- Face blistering (ASTM D714)	
0	Bright and clean	0	No lifting of coating	Frequency	0 = None (#10)	Frequency
1	Staining, no corrosion	1	Lifting or loss of adhesion up to 1/16" (2mm)	0 = None	1 = Very small (#8) <1 mm	0 = None
2	1-10% corrosion product	2	Lifting or loss of adhesion up to 1/8" (3mm)	1 = Few	2 = Small (#6) 1-2 mm	1 = Few
3	11-25% corrosion product	3	Lifting or loss of adhesion up to 1/4" (7mm)	2 = Medium	3 = Sm to Med (#4) 2-3 mm	2 = Medium
4	26-50% corrosion product	4	Lifting or loss of adhesion up to 1/2" (13mm)	3 = Med. Dense	4 = Med to Lg (#2) 3-5 mm	3 = Med. Dense
5	51-100% corrosion product	5	Lifting or loss of adhesion up to >1/2" (>13mm)	4 = Dense	5 = Large (#0) >5mm	4 = Dense

Based on:

- **ASTM D1654**, "Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments"
- **ASTM D714**, "Standard Test Method for Evaluating Degree of Blistering of Paints"



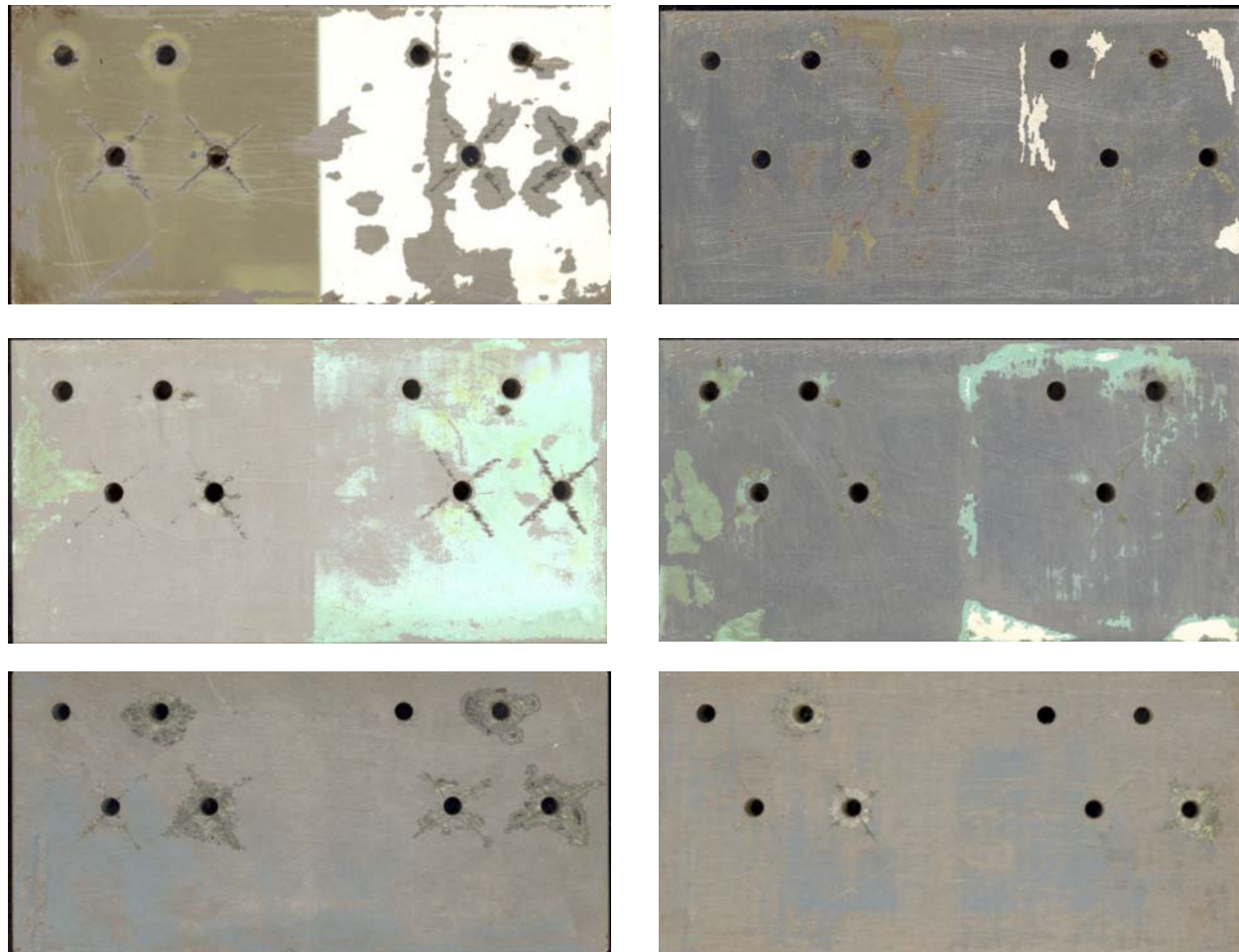
Test Method

	ASTM B117	ASTM G85.A4	KSC Outdoor Exposure Testing
Test Duration	504 hours (3 weeks) of exposure	336 hours (2 weeks) of exposure	9 months of exposure
Rating Interval	Every other day for 1 week, then once a week until test completion	Every other day for 1 week, and every couple days the 2 nd week.	Once a month
Rating Method	Modified Rating Chart	Modified Rating Chart	ASTM D1654, Undercutting rating only



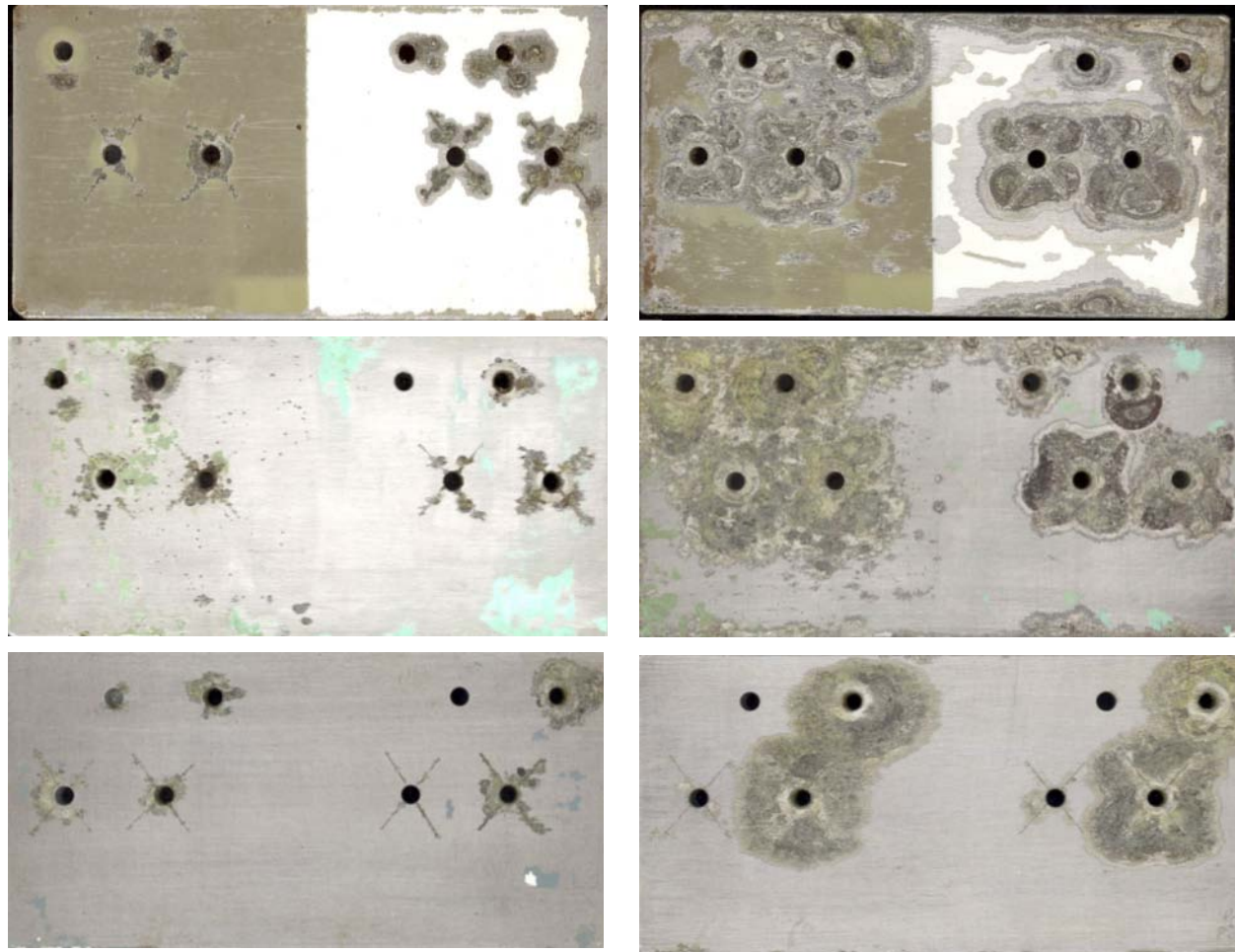
Galvanic Corrosion:

ASTM G85.A4



Galvanic Corrosion:

ASTM G85.A4



United Technologies Corrosion Modeling

- Supplying corrosion data to UT to develop galvanic assembly *life modeling*
 - *Plot when systems fail (date) vs comparing ratings over a test interval*
- Goal – develop life model for coatings and aircraft assemblies



NAVAIR/OSU

Technology Corrosion Collaboration (TCC)

- Understanding the NAVAIR Galvanic Assembly
 - Isolating fasteners and recording current measurements
 - Finding that the fasteners interact with one another through surface electrolyte film
 - Increases the corrosion rate of the “weak link”



NAVAIR/OSU TCC

- Use information gathered in this project to improve the design/develop galvanic corrosion test method(s) for:
 - Paint specifications
 - Corrosion Modeling
 - Acquisition Program Support



Questions?

